

REMARKS

Overview

Claims 1-40 were pending when the Office Action was mailed (April 4, 2008). Applicants herein amend claims 1, 6, 13, 20, 27, and 35, cancel claims 4 and 5, and do not present any new claims. Accordingly, claims 1-3 and 6-40 are currently pending.

The Office Action rejects claims 35, 36, and 40 under 35 U.S.C. § 102(e) over Brunner; rejects claims 1-3, 7-12, 20-22, and 24-26 under 35 U.S.C. § 103(a) over Brunner and Vincent; rejects claims 4-6 and 23 under 35 U.S.C. § 103(a) over Brunner, Vincent, and Claus; rejects claims 13-19, 27, and 29-34 under 35 U.S.C. § 103(a) over Brunner and Plunk; rejects claim 28 over Brunner, Plunk, and Vincent; rejects claims 37 and 38 under 35 U.S.C. § 103(a) over Brunner and Vincent; and rejects claim 39 under 35 U.S.C. § 103(a) over Brunner and Plunk. Applicants respectfully traverse these rejections. Nevertheless, applicants herein amend the claims to clarify the subject matter for which they are seeking protection.

Applicants' Technology

Applicants provide a technique for stabilizing an image taken from a video camera attached to a moving object (e.g., an airplane) using a combination of electronic and mechanical stabilization techniques. Applicants' technique uses an electronic inter-frame (or frame-to-frame) stabilization technique to "mov[e] a display area (or viewport) within a larger image area" based on the movement of the camera. (Specification, ¶ [0018]). This inter-frame stabilization may be based on, for example, the velocity and orientation of the camera or differences between frames. As an example, a camera may capture a 2000 x 2000 pixel image and only display 1500 x 1500 pixels (i.e., a 1500 x 1500 viewport). Because the viewport is 500 pixels smaller than the captured image data in each dimension, the viewport can be moved to compensate for "small-

amplitude jitter." Applicants' technique also uses the inter-frame stabilization adjustment as a basis for adjusting a mechanical line-of-sight controller to compensate for "large-amplitude jitter." (Specification, ¶ [0018]). In this manner, the inter-frame stabilization adjustment is used as a basis for stabilizing an image both mechanically and electronically.

Applied References

Brunner is directed to a camera system for tracking a target from an aircraft. Brunner generates pointing data based on the current position of the aircraft and the current position of the target and provides this information to the camera in order to "track a moving or dynamic target 14b continuously in real time." (Brunner, 1:29-41, 2:26-27). Brunner's "pointing parameters may include an azimuth parameter and an elevation parameter" and "are based on the adjusted latitude and longitude of the aircraft and the known latitude and longitude of the target." (Brunner, 6:21-25). A motor assembly then moves the camera based on the pointing parameters "to maintain the target 14 along the optical axis 0 of the camera." (Brunner, 6:33-35).

Vincent is directed to a system that captures image data and simultaneous camera position and orientation data and uses this data to generate a three-dimensional display of the captured image data. (Vincent, Abstract). As a camera is re-positioned and/or re-focused, Vincent's technique records "acceleration in the X, Y and Z direction as well as...the pitch, roll, and yaw of the camera and [] the distance to the subject." (Vincent, 4:18-21). Vincent later uses this data to determine "the precise position of the camera, its precise orientation, and the position of the subject" in order to generate a three-dimensional image reconstruction. (Vincent, 3:51-54, 4:26-27).

Claus provides a technique for digitally stabilizing images captured using a charge-coupled device ("CCD") attached to a moving or flying carrier. Claus uses

inertial sensors to detect the movement around the pitch and roll axes of the carrier and corrects image data to compensate for the detected movement. To compensate for errors caused by the detected movement, Claus may displace, omit, or duplicate image lines and interpolate neighboring pixels to maintain stabilization accuracy. (Claus, Abstract, 1:56-61, 2:35-41). For example, to correct for movement around the "roll axis," Claus displaces image lines transversely to the direction of flight. As another example, to correct for movement around the "pitch axis," Claus omits or duplicates whole lines and interpolates missing information using neighboring pixels.

Plunk is directed to a technique for converting forward looking video into downlooking image data. (Plunk, Abstract). Plunk captures video image data from an aircraft as the aircraft flies over known ground features. (Plunk, 1:40-43). "After the flight, the film is processed to obtain digitized photographs" which Plunk analyzes to determine changes between known ground control points in consecutive frames. (Plunk, 1:44-45, 54-57). These differences are used to "provide optimal estimates of the position and attitude of the aircraft with respect to each frame of imagery." (Plunk, 2:1-3). Using the estimated position and attitude information associated with each image, Plunk generates a top-down view by warping imagery onto elevation data. (Plunk, Abstract).

Rejections under 35 U.S.C. § 102(e)

Claim 35 now recites "calculating inter-frame stabilization adjustments to account for velocity of the vehicle, the inter-frame stabilization adjustments used to electronically move the viewport from one frame to the next frame; moving the viewport in accordance with the calculated inter-frame stabilization adjustments" and "calculating line-of-sight adjustments for the line-of-sight controller based on the inter-frame stabilization adjustments." The relied-upon portions of Brunner fail to teach or suggest moving a viewport in accordance with the calculated inter-frame stabilization adjustments from

one frame to the next. Instead, Brunner attempts to maintain image stability by adjusting the pointing parameters of a camera based on position information. In contrast, applicants' claimed technology maintains image stability by combining a mechanical line-of-sight adjustment with a method for stabilizing an image electronically by moving a viewport in accordance with an inter-frame stabilization adjustment. Accordingly, claim 35 is patentable over Brunner, as are its dependent claims 36-40.

Rejections under 35 U.S.C. § 103(a)

Claim 1 now recites "calculating an inter-frame stabilization adjustment based on the velocity and orientation of the transport mechanism, the orientation of the camera, the scan and tilt rate of the camera, and distance to the object, the inter-frame stabilization adjustment for adjusting the position of a displayed area of an image," "adjusting the position of the displayed area of the image based on the inter-frame stabilization adjustment," "calculating a line-of-sight adjustment for the line-of-sight controller based on the inter-frame stabilization adjustment," and "controlling the line-of-sight controller in accordance with the calculated line-of-sight adjustment." The Office Action relies on Brunner at 3:47-64 and 6:11-25 and Claus at 1:24-30 and 2:23-27 as disclosing these features. Applicants respectfully disagree that the combination of Brunner and Claus discloses these features. The relied-upon portions of Brunner describe techniques for redirecting a camera based on the position of the camera and a target. The relied-upon portions of Claus describe techniques for digitally stabilizing an image based on readings from inertial sensors by displacing, omitting, and interpolating image lines to maintain stabilization accuracy. Thus, the combination of Brunner and Claus provides an aircraft camera image stabilization system in which the line of sight of the camera is dependent on the position of the target and aircraft while digital stabilization is based on the pitch and roll of a vehicle to which the camera is attached. In other words, Brunner's line of sight adjustment and Claus' digital stabilization are based on different data. In contrast, applicants' technology stabilizes a camera image

by calculating an inter-frame stabilization value and uses this value to stabilize an image electronically and to adjust the mechanical line-of-sight controller for the camera. The combination of Brunner and Claus fails to teach or suggest using the same data (i.e., an inter-frame stabilization adjustment) to electronically adjust an image and adjust a line-of-sight controller for a camera capturing the image. Vincent fails to cure these deficiencies. Accordingly, claim 1 is patentable over the applied references, as are its dependent claims 2-3 and 6-12.

Claim 20 now recites "an electronic stabilization component that provides frame-to-frame image stabilization based on the specified line-of-sight adjustment rate by adjusting the display of an image to remove small-amplitude jitter and that provides to the mechanical line-of-sight controller a new line-of-sight adjustment rate derived from an amount of frame-to-frame image stabilization to account for large-amplitude jitter." The Office Action relies on the rejection of claim 1 in rejecting claim 20. The amendments to claim 20 clarify that the electronic and mechanical stabilization techniques are based on the same data. As discussed above with respect to claim 1, the combination of the relied-upon portions of Brunner, Claus, and Vincent fails to teach or suggest adjusting an image electronically and adjusting a mechanical line-of-sight controller for a camera capturing the image based on the same data. Accordingly, claim 20 is patentable over the applied references, as are its dependent claims 21-26.

Claim 13 now recites "calculating an inter-frame stabilization adjustment based on the determined difference; adjusting the display of the image based on the inter-frame stabilization adjustment to remove small-amplitude jitter; calculating a line-of-sight adjustment for the line-of-sight controller based on the inter-frame stabilization adjustment to account for large-amplitude jitter; and controlling the line-of-sight controller in accordance with the calculated line-of-sight adjustment." The relied-upon portions of Brunner and Plunk fail to disclose adjusting an image based on an inter-frame stabilization. Brunner maintains image stability by adjusting the position of a

camera based on the position of a vehicle to which the camera is attached and the position of a target. Plunk identifies differences between frames to determine the "position and attitude of the aircraft with respect to each frame of imagery." (Plunk, 2:2-3). Plunk uses this information to make a "smooth determination of the orientation of the camera at the moment of exposure of each frame" prior to warping the captured images onto elevation data to generate a top down view. (Plunk, 2:4-5, 19-20). Plunk relies on the differences between frames to determine position and attitude, not to stabilize images of an object captured from a moving camera. Furthermore, the combination of the applied references fails to teach or suggest adjusting an image and a line-of-sight controller based on the same data (i.e., an inter-frame stabilization adjustment). Accordingly, claim 13 is patentable over the applied references, as are its dependent claims 14-19.

Claim 27 now recites "an electronic stabilization component that provides frame-to-frame image stabilization based on a location of an object within the images by adjusting the display of the images to remove small-amplitude jitter and that provides to the mechanical line-of-sight controller a new line-of-sight adjustment rate derived from an amount of frame-to-frame image stabilization to account for large-amplitude jitter." The Office Action relies on the rejection of claim 13 in rejecting claim 27. The amendments to claim 27 clarify that the electronic and mechanical stabilization techniques based on the same data. As discussed above with respect to claim 13, the combination of the relied-upon portions of Brunner and Plunk fails to teach or suggest using the same data (i.e., frame-to-frame image stabilization) to electronically adjust an image and to adjust a mechanical line-of-sight controller for a camera capturing the image. Accordingly, claim 27 is patentable over the applied references, as are its dependent claims 28-34.

Conclusion

In view of the foregoing, applicants submit that the pending application is in condition for allowance and respectfully request reconsideration of the application and a prompt Notice of Allowance. If the Examiner has any questions or believes a telephone conference would expedite prosecution of this application, the Examiner is encouraged to contact the undersigned at (206) 359-8000.

Please charge any underpayment or credit any overpayment to our Deposit Account No. 50-0665, under Order No. 367618016US1 from which the undersigned is authorized to draw.

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